THE CHEMICAL COMPOSITION OF COMET C/2012 S1 (ISON) AS MEASURED WITH CSHELL AT THE NASA-INFRARED TELESCOPE FACILITY. M. A. DiSanti[1,2], B. P. Bonev[1,3], E. L. Gibb[4], G. L. Villanueva[1,3], L. Paganini[1,3], M. J. Mumma[1,2], and A. J. McKay[5,6] [1]Goddard Center for Astrobiology (michael.a.disanti@nasa.gov), [2]NASA-Goddard Space Flight Center, Mail Stop 693.0, 8800 Greenbelt Rd., Greenbelt, MD 20771 [3]Catholic University of America [4]U. Missouri-St. Louis [5]New Mexico State U. [6]U. Texas.

Introduction: Comets, by virtue of their small size and prolonged storage at large heliocentric distances (R_h), remain largely preserved. As a result, their ices encode a record of physical and chemical conditions in the early Solar System [1,2]. The recent apparition of C/2012 S1 (ISON) [3], a dynamically new sun-grazing comet, provided the rare opportunity to both prepare for and subsequently conduct compositional studies to well within 1 AU from the Sun.

The NASA InfraRed Telescope Facility (IRTF) is unique among ground-based IR observatories in its ability to conduct observations during daytime. This capability permitted obtaining compositional measurements of Comet ISON to a minimum solar elongation angle of 20 degrees.

Observations: As part of the world-wide Comet ISON observing campaign, near infrared observations were scheduled on 10 dates between 2013 Nov. 10 (R_h = 0.75 AU) and Nov. 22 (R_h = 0.34 AU) using the IRTF echelle spectrometer (CSHELL; ref. [4]). During this time the evolution of activity revealed evidence of a dynamically evolving coma on short time scales. This permitted searching for changes in composition as continually deeper regions of the nucleus were exposed by erosion of surface layers exposed to the increasingly intense solar radiation field.

High-resolution ($\lambda/\Delta\lambda$ ~ 25,000) spectra of Comet ISON were obtained with CSHELL between R_h = 0.60 and 0.34 AU. Multiple molecules (H_2O, CO, H_2CO, CH_3OH, C_2H_6, C_2H_2, CH_4, HCN, and NH_3) and radicals (OH, NH_2) were targeted and, with the possible exception of CH_4, all were detected on at least one UT date. Production rates will be reported, and possible evolution in abundances relative to H_2O with decreasing R_h, for example as could result from potential compositional heterogeneity in the nucleus, will be discussed. Comparisons will also be made with previous abundance measurements of Comet ISON at larger R_h [5, 6].

Sample Spectra: CSHELL has only 256 spectral channels, so its spectral coverage per setting is limited, being only ~ 0.23 percent of the sampled frequency. This limitation requires settings for specific molecules to be chosen judiciously, and typically means targeting spectral lines that simultaneously include emissions of H_2O (e.g., Figs. 1a, 1d) or prompt OH (denoted OH* in Figs. 1b, 1c), which serves as a proxy for water production provided equivalent OH* line g-factors are known [7].

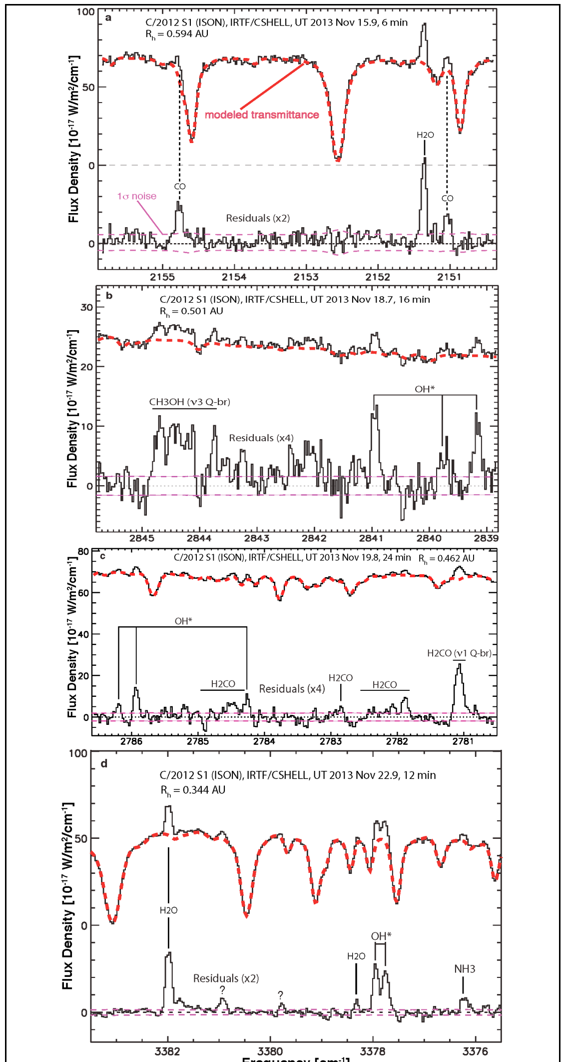

Fig. 1. Spectral extracts (upper black traces in each panel) of comet ISON, representing signal contained within a 1x3 arc-second aperture centered on the position of peak emission intensity. Also shown are the modeled transmittance function (dashed red) and net emission spectrum ("Residuals"; bottom traces). Species responsible for each emission are indicated.

This allows for simultaneous measurement of water production, and avoids systematic uncertainties, for example those associated with differences in slit losses and flux calibration among settings.

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